The University of North Dakota

Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota

Presented to the
ND RAC Meeting
Bismarck, ND

November 9, 2011

Presented by

Nabil Suleiman, Ph.D.
Civil Engineering Department
University of North Dakota

Motivation

Why WMA technology?

- Reduce green house emissions (Plant)
- Reduce energy consumption at the plant
- Extend the paving season into colder weather
- Promote worker safety
- Increase workability at lower temperatures
- Decrease binder aging

Background

- Conventional HMA 285°F to 340°F
- Cold-Mix Asphalt 70°F to 120°F
- Warm Mix Asphalt 212°F to 275°F

Background - Cont'd

How WMA technology works?

- WMAs are produced by incorporating additives into asphalt mixtures to allow production and placement of the mix when heated to temp well below of those of the conventional HMA
- The additive reduces the viscosity of the asphalt binder providing total aggregate coating at 35°F-100°F lower than the typical 300°F+ HMA

Literature Review

Several WMA studies have been conducted at NCAT, Virginia, Wisconsin, Michigan, ..etc.

- Studies used different binders, aggregates, %RAP
- Investigated the effects of lower production temp on the compactibility, volumetrics, moisture susceptibility, rutting potential, fatigue resistance, dynamic modulus values, and curing time
- Compared different WMA technologies, tested lab & field specimens, and compared to control (HMA) samples

Literature Review - Cont'd

WMA studies showed the following results:

- Improved workability and compactibility (higher density) of the mix
- WMA additives did not affect the resilient modulus of asphalt mixes with the same PG binder
- Some studies showed decrease, others showed increase in rutting potential
- Moisture damage increased for mixes with aggregates that had high water absorption
- Reduction in short-term aging improved fatigue resistance

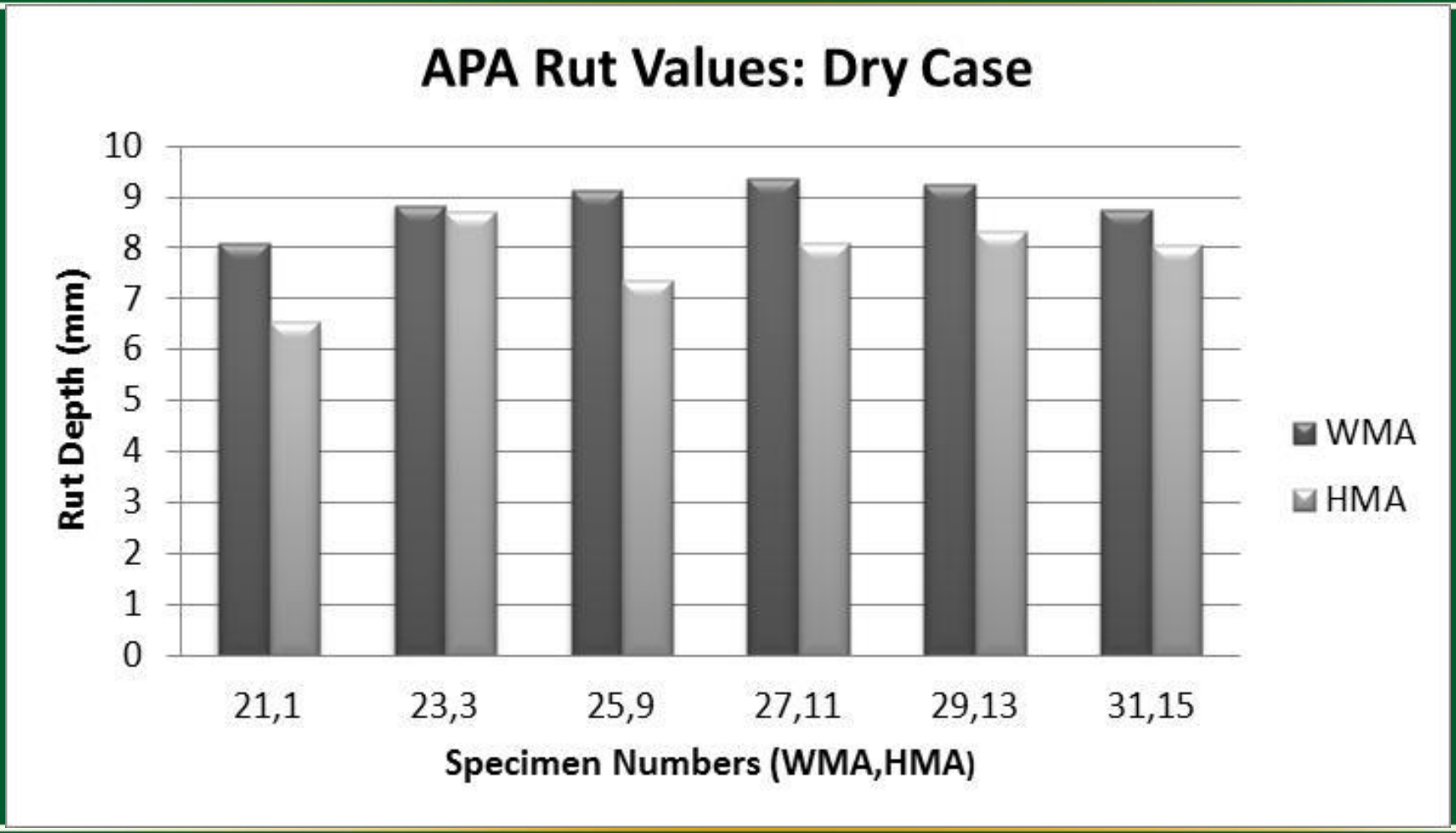
The Big Picture

- What was evaluated?
  - WMA field specimens
  - Control HMA (field specimen)
- Basis for Evaluation
  - APA Rut resistance (Dry & Wet)
- Main variables
  - WMA vs. control (HMA)
  - Dry vs. wet testing

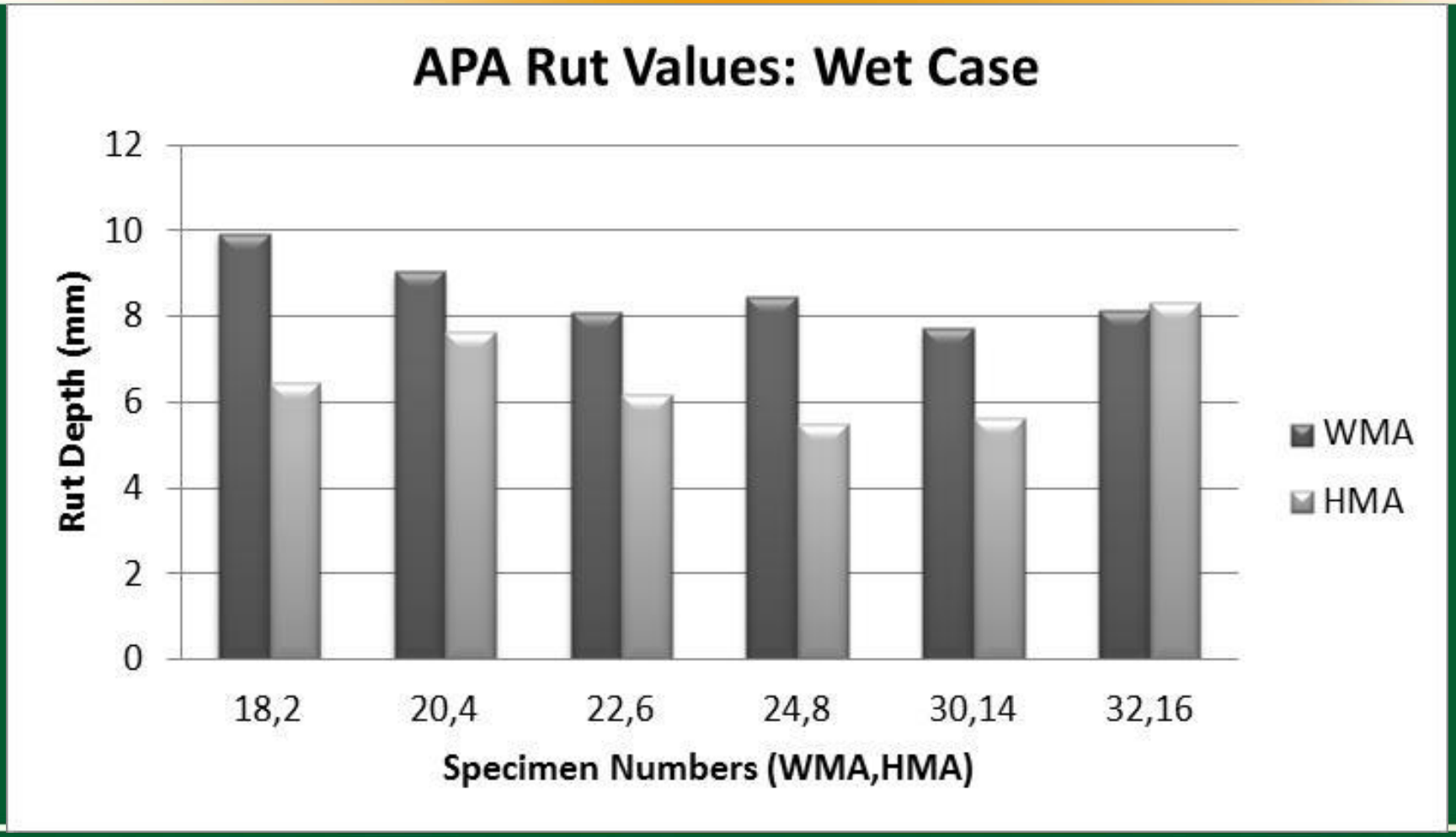
Specimen Collection and Preparation

- A total of 32 specimens were collected (by NDDOT)
  - 24 specimens were needed for testing
  - 12 WMA (6 dry and 6 wet) and 12 HMA (6 dry and 6 wet)
- Cutting specimens to 3 inch height
- Bulk specific gravities and % air voids were determined
- Prior to dry rut testing:
  - Specimens were heated for 6 hours @58°F
- Prior to wet testing:
  - Specimens were conditioned in water for 24 hours @ 58°F

APA Rut Results



APA Rut Results



APA Rut Results

- Generally, WMAs had higher rut values in comparison with the HMA control specimens
  - Dry Condition: WMA higher by 13%
  - Wet Condition: WMA higher by 29%
- 19 specimens passed the 9.0 mm criterion
  - The failed 5 were WMA (3 dry & 2 wet)
  - 6 out of the 7 WMA specimens that passed had rut values > 8.0 mm
- Most air voids 3-5% -- no trend with rutting

Conclusions

- Higher rutting for warm mixes confirms previous research findings fears:
  - Dry Condition: Lower temp for WMA contributes to less aging of binder (less stiffening)
  - Wet Condition: Lower production temp may cause the aggregates to be not fully dry before mixing
- PI is cautious about the use of WMA in ND on a large scale without further testing

Recommendations

- The rut results were based on a small sample size. To make a definitive decision on the utility of warm mixes in ND, the PI recommends:
  - Additional APA rut testing with larger sample size and more variables (different WMA technologies, temp, binders, aggregates, lab vs. field results)
  - Perform other strength tests such as the dynamic modulus, fatigue resistance, and moisture sensitivity
  - Field monitor WMA sections for rut measurements, cracks, stripping, ..etc.

Thank You

The University of North Dakota